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## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<p>(51) International Patent Classification 5 : <b>D03D 11/02</b></p>	<p><b>A1</b></p>	<p>(11) International Publication Number: <b>WO 93/05219</b></p> <p>(43) International Publication Date: 18 March 1993 (18.03.93)</p>
<p>(21) International Application Number: PCT/FI92/00241</p> <p>(22) International Filing Date: 11 September 1992 (11.09.92)</p> <p>(30) Priority data:  914286 12 September 1991 (12.09.91) FI  920540 10 February 1992 (10.02.92) FI</p> <p>(71) Applicant (for all designated States except US): FINN-CLEVER OY [FI/FI]; Laajalammintie 10, SF-50160 Mikkeli (FI).</p> <p>(72) Inventor; and  (75) Inventor/Applicant (for US only): LAITINEN, Mauri [FI/FI]; Suksisepäntie 1 D 10, SF-50160 Mikkeli (FI).</p> <p>(74) Agent: HELKE, Kimmo; Kespat Oy, P.O. Box 601, SF-40101 Jyväskylä (FI).</p>		<p>(81) Designated States: AT, AU, BG, BR, CA, CH, CS, DE, DK, ES, FI, GB, HU, JP, KR, LU, NL, NO, PL, RO, RU, SE, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, SE).</p> <p>Published  <i>With international search report.</i></p>
<p>(54) Title: A METHOD FOR MANUFACTURING A LAMINATING REINFORCED FIBRE STRUCTURE AND A CORRESPONDING REINFORCED FIBRE STRUCTURE</p> <div data-bbox="389 1144 1258 1669" data-label="Image"> </div> <p>(57) Abstract</p> <p>The object of the invention is a method for manufacturing a laminating reinforced fibre structure (1), in which fibre layers (7, 8) made of cross-woven warp or weft yarn bundles are manufactured as a warp structure, these being tied together with ties (9) and a filler (4) is placed in the channel formed by the layers one top of each other and the ties. In accordance with the invention two fiber layers (7, 8) one top of one another are woven together in a manner that is as such known, in such a way that the warp (2) or alternatively weft (3) bundles of yarns run in turn in the upper and lower structures thus forming large channels in relation to the size of the fabric and pieces impermeable to a binder substance is used as a filler (4).</p>		

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A METHOD FOR MANUFACTURING A LAMINATING REINFORCED FIBRE  
STRUCTURE AND A CORRESPONDING REINFORCED FIBRE STRUCTURE

The object of the invention is a method for manufacturing a  
5 laminating reinforced fibre structure, in which fibre layers are  
manufactured as a warp structure from cross-woven warp or weft  
yarn bundles, which are bound to each other by the weave and a  
filling is put into the channel formed by layers and weaves on  
top of one another. The reinforced fibre structure obtained is  
10 intended to be laminated in the form desired. The invention is  
also concerned with the reinforced fibre structure.

Multi-layer reinforced fibre structures are shown in patent  
publications EP 299,309, US 4,854,352, and JP 1-321946(8).  
15 Vorwerk & Co, BRD have demonstrated TechnoTex products, in which  
the woven layers are bound at a considerably short distance from  
each other by special binding fibres, which by themselves lift  
the layers away from each other without pressure.

20 In the aforementioned EP publication a multi-layer fibre  
structure is shown, in which filler fibres are used between and  
inside the layers. The layers are bound with separate binding  
fibres. In several cases the strength between the layers is  
essentially poorer than that in the direction of the layers.

25

In the JP publication multi-layer fibre structures are shown,  
which are woven to one another at regular intervals. The binding  
fibres are disadvantageous in relation to the loading.

30 The intention of this invention is to create a new method for  
manufacturing laminating three-dimensional reinforced fibre  
structures, and a corresponding reinforced fibre structure. The  
characteristic features of the method in accordance with the  
invention are shown in the accompanying Patent Claim 1 and the  
35 characteristic features of the corresponding reinforced fibre  
structure are shown in Patent Claim 6. A large three-dimensional  
structure in relation to the weave is obtained by using large  
fillers in the channels formed by two warp structures on top of  
each other, in which most advantageously either the weft or warp  
40 yarn bundles run back and forwards in the upper and lower

layers, in which case the weave between the layers becomes very strong. The filler makes it possible to shape the three-dimensional reinforced fibre structure to an arbitrary shape on a mold. Level layers are advantageously used on top of and  
5 beneath the reinforced fibre structure in order to improve the surface strength. In principle filler pieces that are not impregnated with binder material in accordance with the invention can also be used in the fibre structures shown in the  
10 aforementioned publications by replacing the filler fibre bundles with these filler pieces. In this way the layer thickness of the structure can be considerably increased and the specific weight reduced.

Foam plastic is lighter than the previously used fibre fillers.  
15 A light structure can also be achieved by using hollow fillers. Even hollow metal pipes can be considered. The specific weight of wood is about half that of fibre material.

In what follows the invention is illustrated by referring to the  
20 accompanying figures, which shown some forms of application of the invention.

Figure 1 shows a two-layered reinforced fibre structure before placing the fillers.

25 Figure 2 shows a finished laminating reinforced fibre structure.

Figure 3 shows a reinforced fibre structure formed on a mold.

Figure 4 shows a finished formed reinforced fibre piece.

Figure 5 shows one possible way of manufacturing thicker  
30 pieces.

Figure 6 shows a beam structure formed with the aid of a reinforced fibre structure in accordance with the invention.

35 Figure 1 shows a two-layer reinforced fibre structure, through the layers may be more in number. What is essential is that the layers 7 and 8 on top of one another continually change sides in such a way that their warps 2 run in turn in the upper and lower layers. Their cross points, i.e. points of changing side,

are formed by ties 9, between which several fibres remain. Here the warps and wefts are formed of suitable bundles of fibres. Glass fibres are typically used. Aramid, carbon, ceramic, or other reinforcing fibres may also be used.

5

The filler pieces must not absorb resin completely, so that the finished product will be light. Foam plastic fillers permit good dampness, heat, and sound insulation. If required foam-type fillers can be removed from a laminated piece.

10

One or several common weft yarns can also be used as binding points.

A reinforced fibre structure in accordance with Figure 1 is taken to the next stage, in which the ties 9 and the inwardly closing channels of the layers 7 and 8 are filled with filler 4, which may be hollow pieces 4', for examples plastic pipes or foam plastic pieces 4". It is advantageous to use closed-cell foam plastic, for example polythene, which does not absorb resin. Other plastics and rubber can also be considered. These pieces do not necessarily need to be round, but can possibly be of some other cross-sectional form.

The reinforced fibre structure can contain, in addition to the structure in accordance with Figure 1, either on one or both sides even layers, which are loosely bound to these layers from between the ties. By means of them it is possible to obtain a great strength in the direction of the surface.

30 The fibre structure in accordance with Figure 2 with its fillers is treated with resin and is set in the mold 6 in accordance with Figure 3. The fillers 4 flex and permit the reinforced fibre structure 1' to conform to the shape of the mold.

35 Figure 4 shows a finished reinforced fibre structure. The fillers 4 except one have been removed. In a corresponding way it is possible to form an arbitrarily formed piece. If a thicker piece is desired layer folding in accordance with Figure 5 can be used, or structures in accordance with Figure 2 can be laid

on top of one another at a suitable angle to each other. The fibre structure can be manufactured in varying thickness to minimize forming.

- 5 Heat-forming technique can also be exploited in the reinforced fibre structure in accordance with the invention. A binding substance, for example polyester, is added to the bundles of fibres that run in a vertical direction to the ties, when after weaving the channels are filled with a core, which temporarily  
10 forms the aforementioned filler. The binding substance can then be melted momentarily with the aid of heat, when a cell structure blank is formed. The intention of the binding substance is to provide the reinforcing fibres with a suitable stiffness for sufficiently long for the laminating blank to be  
15 pressed in the mold into the desired form.

The foam plastic filler may be a thermoplastically treated material, for example polythene, when pieces of the desired shape are manufactured in the mold with the aid of heat  
20 treatment to be laminated.

In the laminating stage the prepreg technique, which is as such known, can be used.

- 25 Between the ties there may be a varying amount, typically 10 - 25, of bundles of yarn running in the direction of the ties. In the test piece the polythene pieces have been of a diameter of 10 - 20 mm. In these normal glass fibre fabric (TEX 2400) was used, which was, however, woven together with the second layer  
30 in a manner in accordance with the invention. Using at least a 5 mm diameter a unique structure is provided.

Wood or metal can be used as materials for the fillers, especially to create adhesion in a laminating piece. A  
35 particularly interesting possibility is to use an expanding compact material as a filler. In this case for example the fillers expand due to the heat of the mold and raise the structure to become stiff.

## Patent Claims

1. A method for manufacturing a laminating reinforced  
5 fibre structure (1), in which layers (7, 8) of cross-woven warp  
or weft yarn bundles are manufactured as a warp structure, these  
being bound to one another by ties (9) and a filler (4) is  
placed in the channel formed by the layers (7, 8) and the ties,  
characterized in that two fibre layers (7, 8) are woven together  
10 on top of one another in a manner that is as such known in such  
a way that the warp (2) or alternatively the weft bundles of  
yarn (3) run one after the other in the upper and lower  
structure forming in relation to the size of the fabric large  
channels, and pieces that are impermeable to binder substances  
15 are used as filler (4).

2. A method in accordance with Patent Claim 1,  
characterized in that foam plastic (4") is used as a filler (4),  
advantageously closed cell foam plastic.

20

3. A method in accordance with Patent Claim 1,  
characterized in that hollow pieces (4') are used as a filler  
(4).

25 4. A method in accordance with Patent Claim 1,  
characterized in that wood is used as the material of the filler  
(4).

5. A method in accordance with Patent Claim 1,  
30 characterized in that metal is used as the material of the  
filler (4).

6. A method in accordance with Patent Claim 1,  
characterized in that a binder substance is used transverse to  
35 the ties (9), which binder substance is stiffened against a core  
in order to form a blank, after which the core is removed.

7. A method in accordance with Patent Claim 1,  
characterized in that some compact material is used as a filler,

which expands due to the effect of some external treatment, for example heat.

8. A reinforced fibre structure (1), in which there is  
5 a two or more layered structure, which layers (7, 8) are bound  
to each other by ties (9) that together with them form channels,  
in which fillers (4) are placed, and which fibre structure is  
intended to be laminated in the desired form, characterized in  
that the fillers (4) are of a material impermeable to the binder  
10 substance.

9. A reinforced fibre structure (1) in accordance with  
Patent Claim 8, characterized in that foam plastic (4") is used  
as the filler.  
15

10. A reinforced fibre structure (1) in accordance with  
Patent Claim 8, characterized in that one of the following,  
plastic, rubber, wood, metal is used as the filler.

11. A reinforced fibre structure (1) in accordance with  
Patent Claims 8, 9, or 10, characterized in that the two fibre  
layers (7, 8) in the fibre structure that lie on top of each  
other are woven together in such a way the warp (2) or alter-  
natively the weft yarn bundles (3) run in turn in the upper or  
25 lower structure thus forming large channels in relation to the  
size of the fabric.

12. A reinforced fibre structure (1) in accordance with  
one of Patent Claims 8 - 11, characterized in that at least one  
30 side of the reinforced fibre structure has a continuous fibre  
layer (5).

13. A reinforced fibre structure (1) in accordance with  
one of Patent Claims 8 - 11, characterized in that the diameter  
35 of the filler is at least 5 mm.

14. A reinforced fibre structure (1) in accordance with  
one of Patent Claims 8 - 11, characterized in that a hollow  
piece (4') is the filler.

15. A reinforced fibre structure (1) in accordance with Patent Claim 11, characterized in that the layers interlocking with each other have one or more common warp/weft yarn at the tie points.

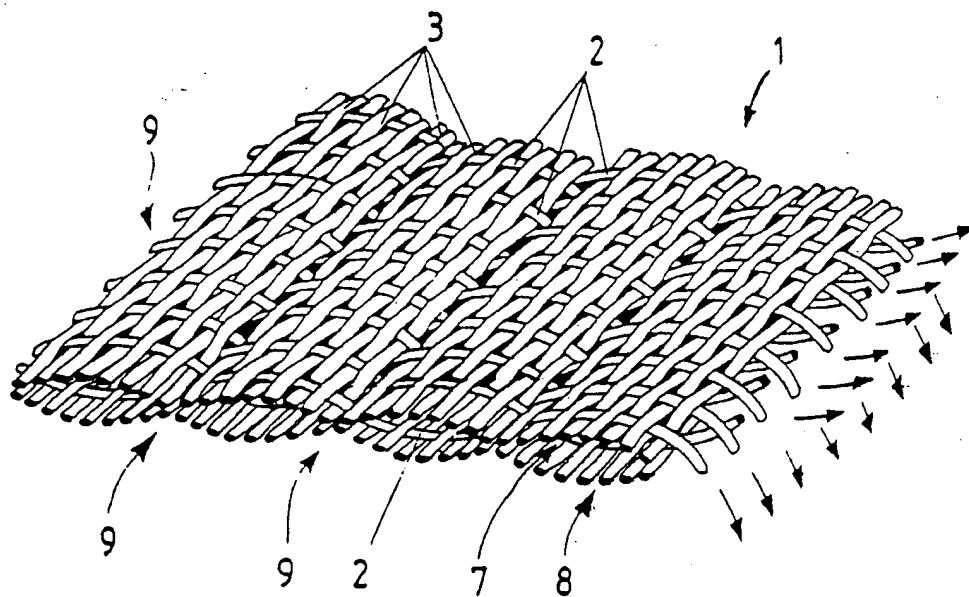


Fig. 1

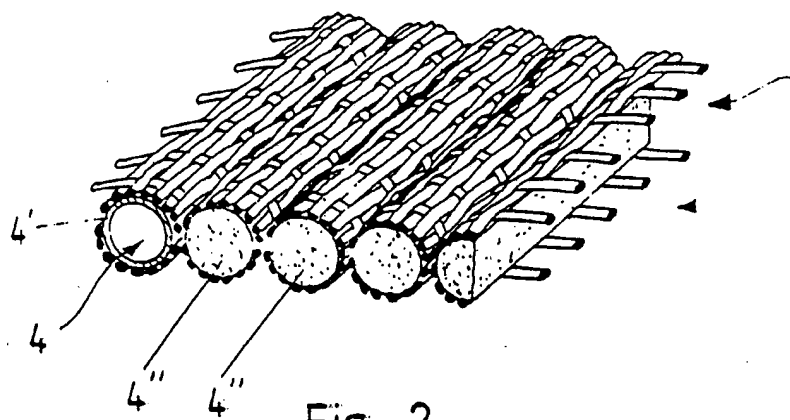


Fig. 2

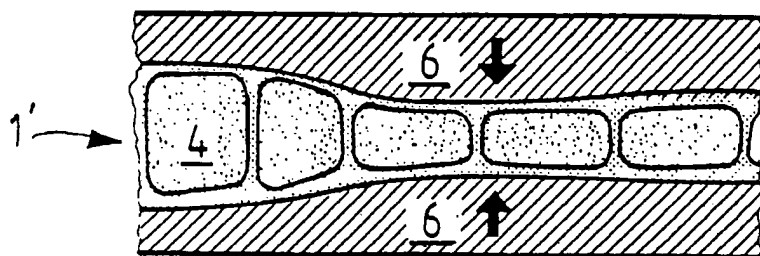


Fig. 3

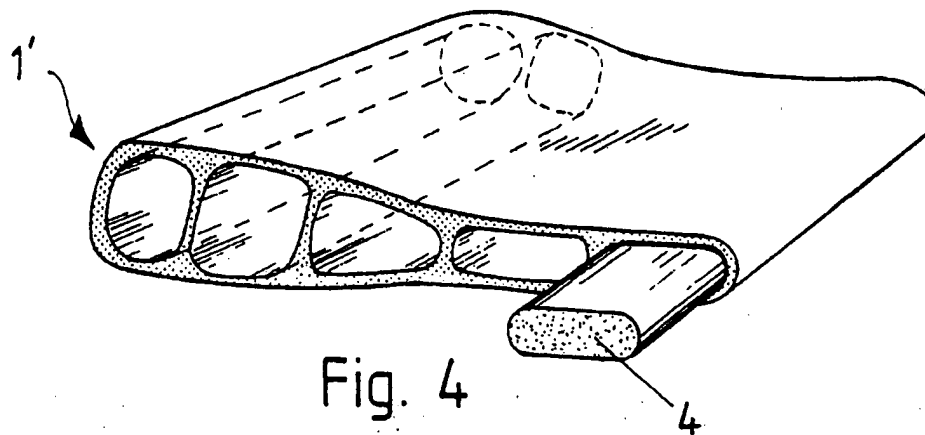


Fig. 4

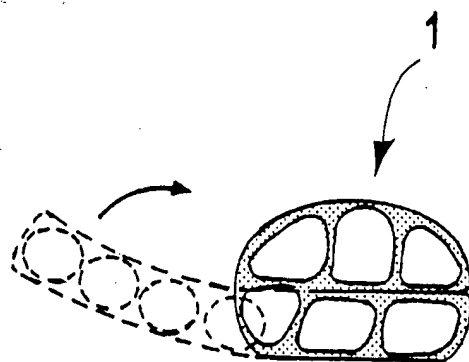


Fig. 5

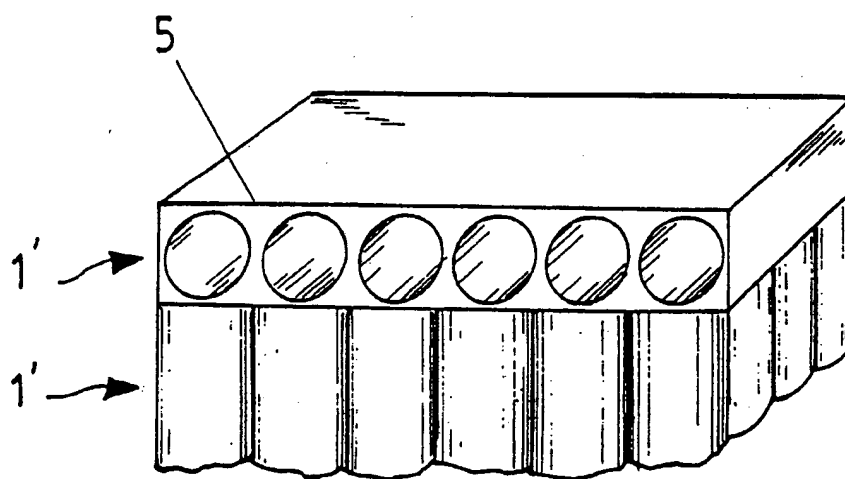


Fig. 6

# INTERNATIONAL SEARCH REPORT

International Application No PCT/FI 92/00241

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (If several classification symbols apply, indicate all) <sup>5</sup> According to International Patent Classification (IPC) or to both National Classification and IPC <b>IPC5: D 03 D 11/02</b>														
<b>II. FIELDS SEARCHED</b> <div style="text-align: center; border: 1px solid black; padding: 2px;">Minimum Documentation Searched<sup>7</sup></div> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 25%; border: 1px solid black; padding: 2px;">Classification System</td> <td style="border: 1px solid black; padding: 2px;">Classification Symbols</td> </tr> <tr> <td style="border: 1px solid black; padding: 5px; vertical-align: top;">IPC5</td> <td style="border: 1px solid black; padding: 5px; vertical-align: top;">D 03 D; B 32 B; B 29 B; B 29 D; B 29 C</td> </tr> </table> <div style="text-align: center; border: 1px solid black; padding: 2px;">Documentation Searched other than Minimum Documentation to the extent that such Documents are included in Fields Searched<sup>8</sup></div> <p style="padding: 5px;">SE,DK,FI,NO classes as above</p>			Classification System	Classification Symbols	IPC5	D 03 D; B 32 B; B 29 B; B 29 D; B 29 C								
Classification System	Classification Symbols													
IPC5	D 03 D; B 32 B; B 29 B; B 29 D; B 29 C													
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT<sup>9</sup></b> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%; padding: 2px;">Category<sup>*</sup></th> <th style="width: 60%; padding: 2px;">Citation of Document,<sup>11</sup> with indication, where appropriate, of the relevant passages<sup>12</sup></th> <th style="width: 30%; padding: 2px;">Relevant to Claim No.<sup>13</sup></th> </tr> </thead> <tbody> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="padding: 5px;">GB, A, 1277260 (AROVA NIEDERLENZ AKTIENGESELLSCHAFT ET AL) 7 June 1972, see figures 1,4; claim 1 <div style="text-align: center;">--</div></td> <td style="text-align: center; vertical-align: top; padding: 5px;">1-15</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="padding: 5px;">EP, A2, 0190039 (ASAHI KASEI KOGYO KABUSHIKI KAISHA) 6 August 1986, see page 26, line 8 - line 13; page 10; claim 1 <div style="text-align: center;">--</div></td> <td style="text-align: center; vertical-align: top; padding: 5px;">1-15</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="padding: 5px;">EP, A2, 0299309 (VORWERK &amp; CO. INTERHOLDING GMBH) 18 January 1989, see figure 2; claim 1 <div style="text-align: center;">--</div><div style="text-align: center;">-----</div></td> <td style="text-align: center; vertical-align: top; padding: 5px;">1-15</td> </tr> </tbody> </table>			Category <sup>*</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>	A	GB, A, 1277260 (AROVA NIEDERLENZ AKTIENGESELLSCHAFT ET AL) 7 June 1972, see figures 1,4; claim 1 <div style="text-align: center;">--</div>	1-15	A	EP, A2, 0190039 (ASAHI KASEI KOGYO KABUSHIKI KAISHA) 6 August 1986, see page 26, line 8 - line 13; page 10; claim 1 <div style="text-align: center;">--</div>	1-15	A	EP, A2, 0299309 (VORWERK & CO. INTERHOLDING GMBH) 18 January 1989, see figure 2; claim 1 <div style="text-align: center;">--</div> <div style="text-align: center;">-----</div>	1-15
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<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p><sup>*</sup> Special categories of cited documents:<sup>10</sup></p> <p><sup>"A"</sup> document defining the general state of the art which is not considered to be of particular relevance</p> <p><sup>"E"</sup> earlier document but published on or after the international filing date</p> <p><sup>"L"</sup> document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p><sup>"O"</sup> document referring to an oral disclosure, use, exhibition or other means</p> <p><sup>"P"</sup> document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 45%;"> <p><sup>"T"</sup> later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p><sup>"X"</sup> document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p><sup>"Y"</sup> document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p><sup>"&amp;"</sup> document member of the same patent family</p> </div> </div>														
<b>IV. CERTIFICATION</b> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; border: 1px solid black; padding: 5px;">Date of the Actual Completion of the International Search <b>16th December 1992</b></td> <td style="width: 50%; border: 1px solid black; padding: 5px;">Date of Mailing of this International Search Report <b>22-12-1992</b></td> </tr> <tr> <td style="border: 1px solid black; padding: 5px;">International Searching Authority  <b>SWEDISH PATENT OFFICE</b></td> <td style="border: 1px solid black; padding: 5px;">Signature of Authorized Officer  <b>Nils Ekström</b></td> </tr> </table>			Date of the Actual Completion of the International Search <b>16th December 1992</b>	Date of Mailing of this International Search Report <b>22-12-1992</b>	International Searching Authority  <b>SWEDISH PATENT OFFICE</b>	Signature of Authorized Officer  <b>Nils Ekström</b>								
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# ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. PCT/FI 92/00241

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.  
The members are as contained in the Swedish Patent Office EDP file on 02/12/92  
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Patent document cited in search report	Publication date	Patent family member(s)		Publication date
GB-A- 1277260	72-06-07	AT-B-	319147	74-12-10
		BE-A-	753303	71-01-11
		CH-A-	497628	70-10-15
		DE-A-B-C	2046845	71-04-01
		FR-A-	2060612	71-06-18
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		AU-D-	5280786	86-08-07
		CA-A-	1275025	90-10-09
		JP-A-	61179337	86-08-12
		US-A-	4853269	89-08-01
EP-A2- 0299309	89-01-18	DE-A-	3819440	89-01-26
		JP-A-	1097233	89-04-14
		US-A-	4931345	90-06-05